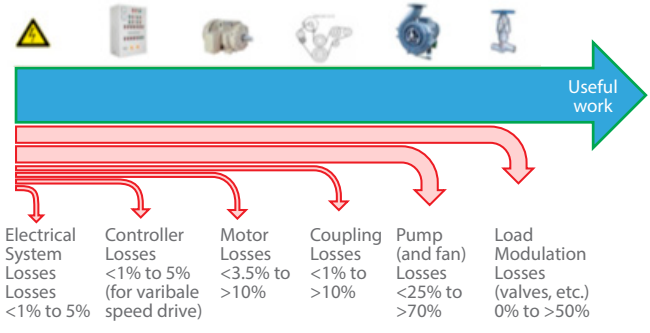
Better Plants
U.S. DEPARTMENT OF ENERGY

Pump System *Info Card*

Top 10 Energy Conservation Measures

1. Shut down pumps when not needed by manufacturing processes
2. Operate the minimum number of pumps that systems require
3. Use VFD instead of throttle valve for flow control
4. Trim or change pump impellers on oversized pumps
5. Reduce pipe and valve pressure losses
6. Re-tune pumping system when manufacturing process requirements change
7. Restore internal housing clearance
8. Replace worn throat bushings, wear rings, impellers, and pump bowls
9. Install new properly sized/selected pumps
10. Replace standard efficiency motors with NEMA premium motors

Pump System Energy Losses



**Courtesy of Bhaskaran Gopalakrishnan*

Pump Brake Horse Power Formula

$$\text{Pump Brake Horse Power (hp)} = \frac{\text{Flow Rate (GPM)} \times \text{Head (ft w.c.)} \times SG}{3960 \times \text{Pump efficiency}}$$

Pump Affinity Laws

$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1}$$

Q = Pump flow rate

$$\frac{H_2}{H_1} = \left(\frac{N_2}{N_1}\right)^2$$

N = Pump speed
H = Pump head

$$\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^3$$

P = Pump power

Rules of Thumb

1. Annual motor operation cost: $300/hp*
2. Decreasing pump flow rate by 50% can reduce pump power by 88%

** Based on 5 cents/kWh, 93% efficiency, 3 shifts, 7 days a week operation, two weeks off/ downtime.*

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ADVANCED MANUFACTURING OFFICE

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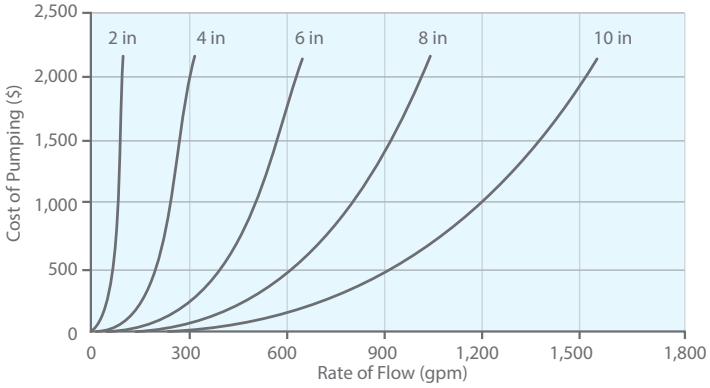
Unit Conversion

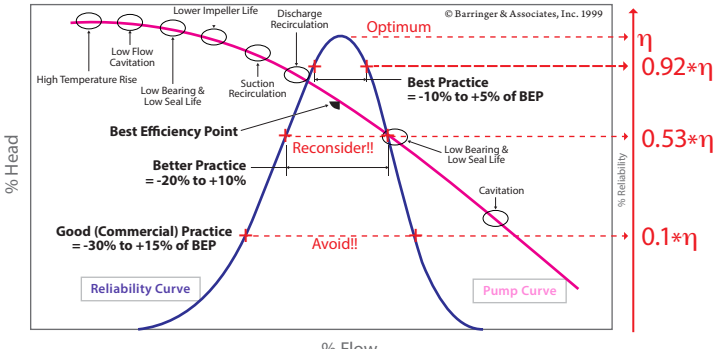
1 ft w.c. = 0.43 psi; 1 GPM = 0.00144 MGD; 1 hp = 0.746 kW

Annual Water Pumping Cost for 1,000 Feet of Pipe



**Based on 1,000 ft. for clean iron and steel pipes (schedule 40) for pumping 70°F water. Electricity rate of 0.05 $/kWh and 8,760 operating hours annually. Combined pump and motor efficiency of 70%.*

Pump Curve Sensitivity for Pump Reliability



**Courtesy of P. Barringer*

Energy Cost for Pump Driven by 100-hp Motor

Operating Time	Energy Costs for Various Electricity Costs				
	2¢ per kWh	4¢ per kWh	6¢ per kWh	8¢ per kWh	10¢ per kWh
1 hour	$1.60	$3.30	$4.90	$6.60	$8.20
24 hours	$39	$79	$119	$159	$198
1 month	$1,208	$2,416	$3,625	$4,833	$6,042
1 year	$14,500	$29,000	$43,600	$58,000	$72,600

Resources

1. Integrated Energy Tool Suite by US Department of Energy
2. Improving Pumping System Performance: A Sourcebook for Industry by US Department of Energy
3. Pump Tip Sheets by US Department of Energy